Scientific Objectives & Capabilities of NGST

Objectives

The Next Generation Space Telescope (NGST) mission is an important element of the NASA Space Science Enterprise strategic plan and addresses several of NASA's long range science objectives:

- Understand the structure of the universe, from its earliest beginnings to its ultimate fate;
- Understand how galaxies, stars, and planets form, interact, and evolve.

The power of NGST stems from its large, cold optics and low astronomical background. NGST is optimized for sensitivity in the infrared (0.6-10+ µm) where it may observe the red shifted light from the first stars and galaxies. The same capabilities enable NGST's vision to penetrate the veils of dust around star-forming regions and in compact galactic nuclei and observe the infrared signatures of early protostars and the formation of complex molecules that may be important to early life forms. The Ad Hoc Science Working Group (ASWG) identified and prioritized five major themes for NGST science:

- Cosmology and the Structure of the Universe
- The Origin and Evolution of Galaxies
- The History of the Milky Way and its Neighbors
- The Birth and Formation of Stars
- The Origin and Evolution of Planetary Systems

These themes address the origins of planets, stars, galaxies, and larger structures within the Universe. Each theme was expanded into a set of potential scientific observations comprising the Design Reference Mission (DRM) and, by design, requiring approximately half of the nominal NGST 5-year, mission-life to complete [http://www.ngst.nasa.gov/science/drm.html]. Although we cannot anticipate the path of science during the development of NGST, we anticipate that programs such as these will be developed by the NGST user community. Of the 23 DRM programs, the ASWG selected seven to represent the NGST "core" mission.

1. Formation and Evolution of Galaxies: Imaging Surveys
2. Formation and Evolution of Galaxies: Spectroscopic Surveys
3. Mapping Dark Matter (using strong and weak lensing)
4. Searching for the Epoch of Re-ionization
5. Measuring Cosmological Parameters (Supernovae)
6. Formation and Evolution of Galaxies: Obscured Star formation and AGN
7. Physics of Star Formation (near and mid-IR imaging and spectroscopy)

These programs guided the Phase A studies of the Observatory and its scientific instruments. While they emphasize the high redshift universe, NGST will provide unique capabilities in the near and mid-infrared for a wide range of astronomical pursuits. We encourage the NGST science teams and interdisciplinary scientists to consider how the core NGST capabilities can be best utilized by the astronomy community.

Reference Telescope, Instrument Suite and The Scientific Capabilities of NGST

For the purposes of this AO the reference architectures and science instruments are defined as:

- 6-m clear aperture, passively cooled to 50K
- 2 μm diffraction limited imaging quality
- 20 micron square pixels
- 1 - 10 μm wavelength range with zodiacal light limited imaging performance with extended performance to 0.6 and 28 μm.
- Imaging and spectroscopic instrumentation over this wavelength range

The reference science instrument complement includes:

- A wide-field (approximately 16 sq-arcmin FOV) near-infrared camera, sensitive over a wavelength range of 0.6-5.0 μm
- A spectrograph (approximately 9 sq-arcmin FOV) sensitive over a wavelength range of 1-5 μm and capable of $R \sim 1000$ multi-object spectroscopy for over 100 objects as well as high sensitivity $R \sim 100$ spectroscopy.
- A general purpose Mid-Infrared camera/spectrograph (approximately 4 sq-arcmin FoV) capable of broad-band imagery and $R \sim 3$-1500 spectroscopy over the wavelength range 5 - 28 μm

The non-sidereal tracking capabilities of the NGST are not yet determined. Once the observatory prime contractor is chosen and instrument providers selected, the project will participate in a study of the feasibility and costs associated with such a capability. For the purposes of this AO alone proposers may assume an NGST observatory that supports tracking rates up to 0.015 arcsec/sec over a 1000 second exposure. All other level 2 requirements must be met during the period of active tracking.

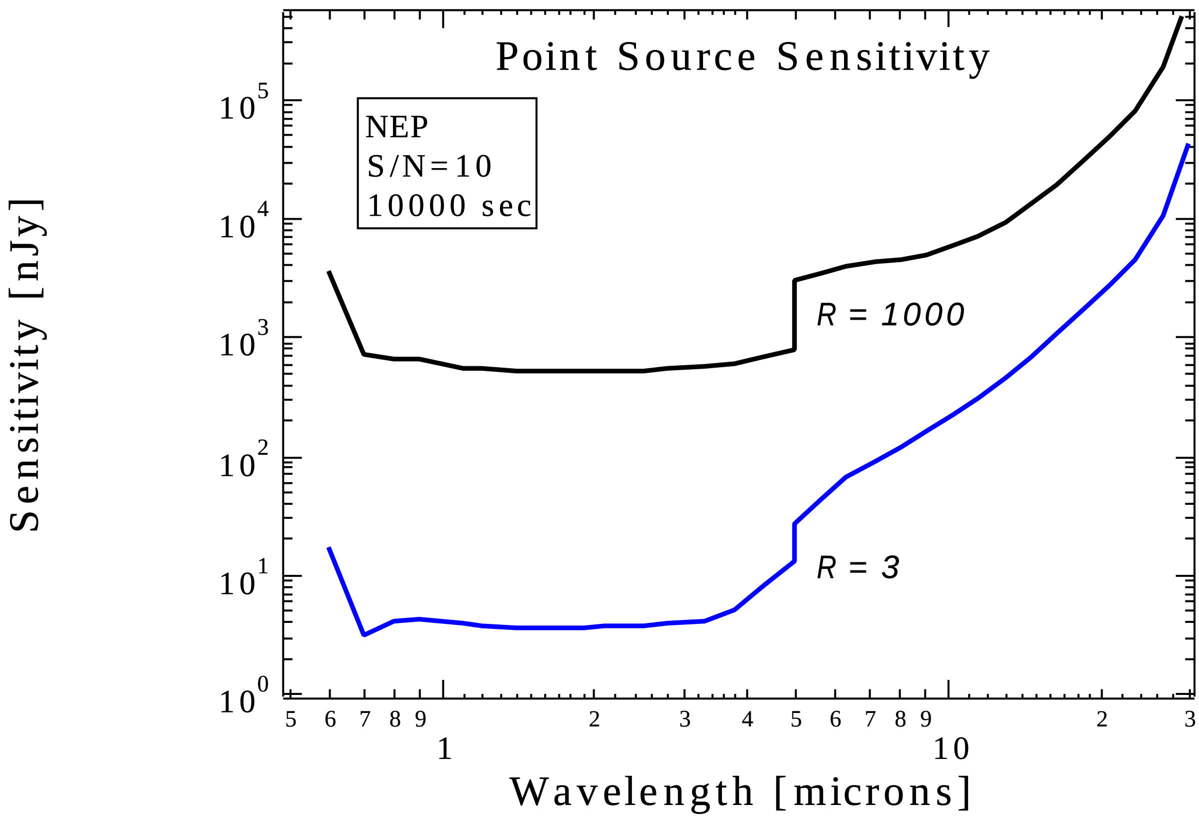

Figure 1: shows the approximate imaging and spectroscopic sensitivities for a point source at the North Ecliptic Pole (NEP) that can be achieved with the reference telescope and instrument suite.

The following assumptions are included in the calculations depicted in figures 1 and 2:

- 6m diameter circular primary mirror with 90% area fill factor,
- COBE DIRBE zodiacal backgrounds (Wright, 1998, Ap.J., 496, 1),
- Detector characteristics described in http://www.ngst.nasa.gov/cgi-bin/doc?Id=641 (Pixel sizes for NIR and MIR detectors defined to be the mid point for the acceptable ranges)
- The Observatory self-generated thermal background is negligible for $\lambda \leq 5$ µm,
- PSF characteristics consistent with those in the NGST Level 2 requirements (sharpness function from NGST Monograph 7),
- OTE throughput compatible with gold coatings as stated in level 2 requirement 3.2.5.3.

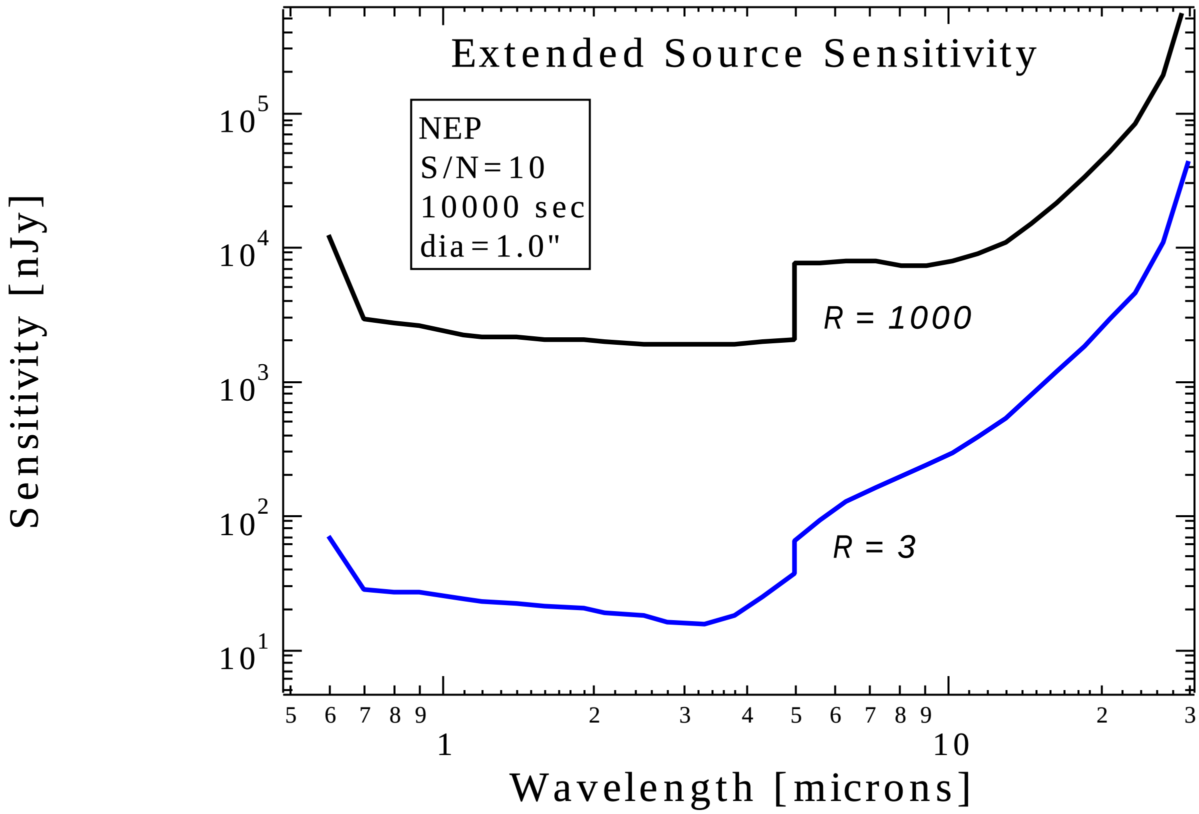

Figure 2 shows the approximate imaging and spectroscopic sensitivities for an extended source with a 1 arcsecond diameter located at the North Ecliptic Pole (NEP) that can be achieved with the reference telescope and instrument suite.

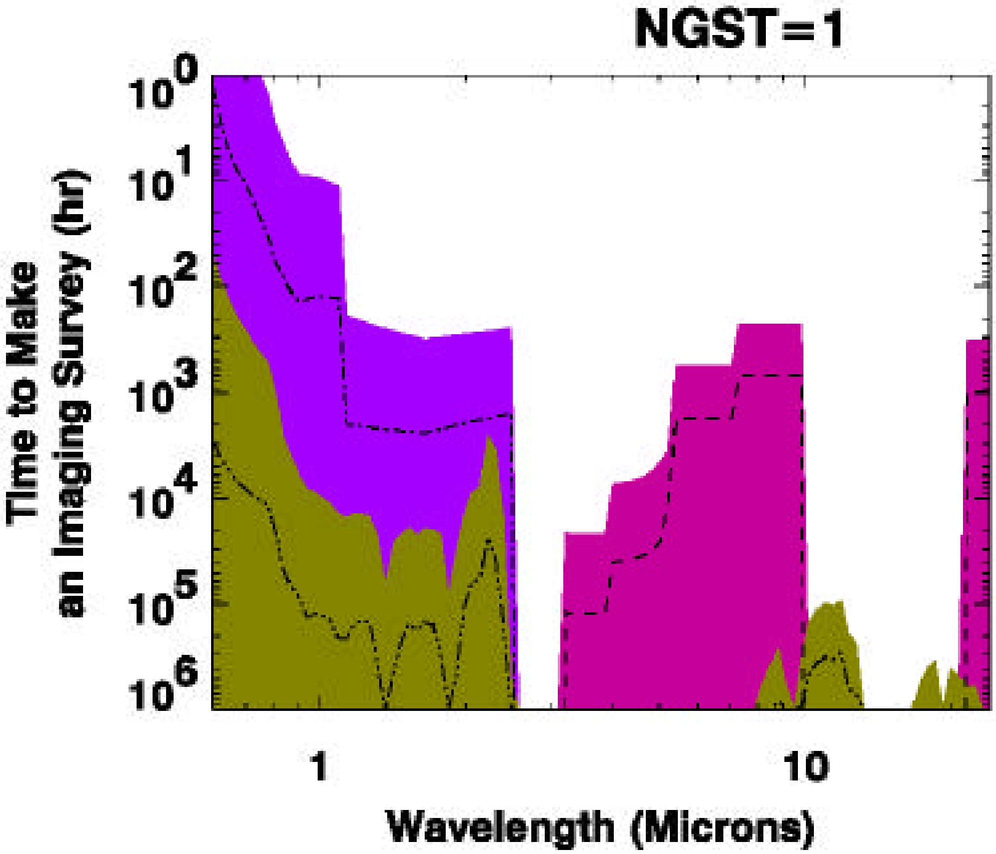

Figure 3 indicates the NGST "discovery space" for wide-field imaging compared to those of other facilities The figure depicts the time required to complete a imaging survey as a function of wavelength for NGST (top line), HST (dark shaded area), an 8m ground telescope (darkest area), and SIRTF (lightest area). The dashed lines represent the case when the aforementioned telescopes are compared with an 8m NGST.